

$\psi(4415)$ $I^G(J^{PC}) = 0^-(1^- -)$ **$\psi(4415)$ MASS**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
4421 ± 4 OUR ESTIMATE			
4415.1± 7.9	¹ ABLIKIM	08D BES2	$e^+ e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •			
4412 ± 15	² MO	10 RVUE	$e^+ e^- \rightarrow$ hadrons
4411 ± 7	³ PAKHLOVA	08A BELL	$10.6 e^+ e^- \rightarrow D^0 D^- \pi^+ \gamma$
4425 ± 6	⁴ SETH	05A RVUE	$e^+ e^- \rightarrow$ hadrons
4429 ± 9	⁵ SETH	05A RVUE	$e^+ e^- \rightarrow$ hadrons
4417 ± 10	BRANDELIK	78C DASP	$e^+ e^-$
4414 ± 7	SIEGRIST	76 MRK1	$e^+ e^-$
1 Reanalysis of data presented in BAI 02C. From a global fit over the center-of-mass energy region 3.7–5.0 GeV covering the $\psi(3770)$, $\psi(4040)$, $\psi(4160)$, and $\psi(4415)$ resonances. Phase angle fixed in the fit to $\delta = (234 \pm 88)^\circ$.			
2 Reanalysis of data presented in BAI 00 and BAI 02C. From a global fit over the center-of-mass energy 3.8–4.8 GeV covering the $\psi(4040)$, $\psi(4160)$ and $\psi(4415)$ resonances and including interference effects.			
3 Systematic uncertainties not estimated.			
4 From a fit to Crystal Ball (OSTERHELD 86) data.			
5 From a fit to BES (BAI 02C) data.			

 $\psi(4415)$ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
62 ±20 OUR ESTIMATE			
71.5±19.0	⁶ ABLIKIM	08D BES2	$e^+ e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •			
118 ±32	⁷ MO	10 RVUE	$e^+ e^- \rightarrow$ hadrons
77 ±20	⁸ PAKHLOVA	08A BELL	$10.6 e^+ e^- \rightarrow D^0 D^- \pi^+ \gamma$
119 ±16	⁹ SETH	05A RVUE	$e^+ e^- \rightarrow$ hadrons
118 ±35	¹⁰ SETH	05A RVUE	$e^+ e^- \rightarrow$ hadrons
66 ±15	BRANDELIK	78C DASP	$e^+ e^-$
33 ±10	SIEGRIST	76 MRK1	$e^+ e^-$
6 Reanalysis of data presented in BAI 02C. From a global fit over the center-of-mass energy region 3.7–5.0 GeV covering the $\psi(3770)$, $\psi(4040)$, $\psi(4160)$, and $\psi(4415)$ resonances. Phase angle fixed in the fit to $\delta = (234 \pm 88)^\circ$.			
7 Reanalysis of data presented in BAI 00 and BAI 02C. From a global fit over the center-of-mass energy 3.8–4.8 GeV covering the $\psi(4040)$, $\psi(4160)$ and $\psi(4415)$ resonances and including interference effects.			
8 Systematic uncertainties not estimated.			
9 From a fit to Crystal Ball (OSTERHELD 86) data.			
10 From a fit to BES (BAI 02C) data.			

 $\psi(4415)$ DECAY MODES

Due to the complexity of the $c\bar{c}$ threshold region, in this listing, “seen” (“not seen”) means that a cross section for the mode in question has been measured at effective \sqrt{s} near this particle’s central mass value, more (less) than 2σ above zero, without regard to any peaking behavior in \sqrt{s} or absence thereof. See mode listing(s) for details and references.

Mode	Fraction (Γ_i/Γ)	Confidence level
$\Gamma_1 D\bar{D}$	not seen	
$\Gamma_2 D^0\bar{D}^0$	seen	
$\Gamma_3 D^+D^-$	seen	
$\Gamma_4 D^*\bar{D} + \text{c.c.}$	not seen	
$\Gamma_5 D^*(2007)^0\bar{D}^0 + \text{c.c.}$	seen	
$\Gamma_6 D^*(2010)^+\bar{D}^- + \text{c.c.}$	seen	
$\Gamma_7 D^*\bar{D}^*$	not seen	
$\Gamma_8 D^*(2007)^0\bar{D}^*(2007)^0 + \text{c.c.}$	seen	

NODE=M073M

NODE=M073M

→ UNCHECKED ←

OCCUR=2

NODE=M073M;LINKAGE=AB

NODE=M073M;LINKAGE=MO

NODE=M073M;LINKAGE=NS

NODE=M073M;LINKAGE=ST

NODE=M073M;LINKAGE=SE

NODE=M073W

NODE=M073W

→ UNCHECKED ←

OCCUR=2

NODE=M073W;LINKAGE=AB

NODE=M073W;LINKAGE=MO

NODE=M073W;LINKAGE=NS

NODE=M073W;LINKAGE=ST

NODE=M073W;LINKAGE=SE

NODE=M073215;NODE=M073

NODE=M073

DESIG=7;OUR EVAL;→ UNCHECKED ←

DESIG=8

DESIG=9

DESIG=10;OUR EVAL;→ UNCHECKED ←

DESIG=11

DESIG=12

DESIG=13;OUR EVAL;→ UNCHECKED ←

DESIG=14

Γ_9	$D^*(2010)^+ D^*(2010)^- + \text{c.c.}$	seen			DESIG=15
Γ_{10}	$D^0 D^- \pi^+ (\text{excl. } D^*(2007)^0 \bar{D}^0 + \text{c.c.}, D^*(2010)^+ D^- + \text{c.c.})$	< 2.3	%	90%	DESIG=4
Γ_{11}	$D \bar{D}_2^*(2460) \rightarrow D^0 D^- \pi^+ + \text{c.c.}$	(10 \pm 4) %			DESIG=5
Γ_{12}	$D^0 \bar{D}^* \pi^+ + \text{c.c.}$	< 11	%	90%	DESIG=6
Γ_{13}	$D_s^+ D_s^-$	not seen			DESIG=16
Γ_{14}	$D_s^{*+} D_s^- + \text{c.c.}$	seen			DESIG=17
Γ_{15}	$D_s^{*+} D_s^{*-}$	not seen			DESIG=18
Γ_{16}	$e^+ e^-$	$(9.4 \pm 3.2) \times 10^{-6}$			DESIG=1

$\psi(4415)$ PARTIAL WIDTHS

$\Gamma(e^+ e^-)$

VALUE (keV)

0.58 \pm 0.07 OUR ESTIMATE**0.35 \pm 0.12**

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.4 to 0.8

0.72 \pm 0.110.64 \pm 0.230.49 \pm 0.130.44 \pm 0.14

DOCUMENT ID

TECN

COMMENT

Γ₁₆

11	ABLIKIM	08D	BES2	$e^+ e^- \rightarrow \text{hadrons}$
12	MO	10	RVUE	$e^+ e^- \rightarrow \text{hadrons}$
13	SETH	05A	RVUE	$e^+ e^- \rightarrow \text{hadrons}$
14	SETH	05A	RVUE	$e^+ e^- \rightarrow \text{hadrons}$
	BRANDELIK	78C	DASP	$e^+ e^-$
	SIEGRIST	76	MRK1	$e^+ e^-$

11 Reanalysis of data presented in BAI 02C. From a global fit over the center-of-mass energy region 3.7–5.0 GeV covering the $\psi(3770)$, $\psi(4040)$, $\psi(4160)$, and $\psi(4415)$ resonances. Phase angle fixed in the fit to $\delta = (234 \pm 88)^\circ$.

12 Reanalysis of data presented in BAI 00 and BAI 02C. From a global fit over the center-of-mass energy 3.8–4.8 GeV covering the $\psi(4040)$, $\psi(4160)$ and $\psi(4415)$ resonances and including interference effects. Four sets of solutions are obtained with the same fit quality, mass and total width, but with different $e^+ e^-$ partial widths. We quote only the range of values.

13 From a fit to Crystal Ball (OSTERHELD 86) data.

14 From a fit to BES (BAI 02C) data.

NODE=M073220

NODE=M073W1

NODE=M073W1

→ UNCHECKED ←

OCCUR=2

NODE=M073W1;LINKAGE=AB

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NODE=M073R05

NODE=M073R02

NODE=M073R02

NODE=M073R06

NODE=M073R06

NODE=M073R07

NODE=M073R07

NODE=M073R03

NODE=M073R03

$\psi(4415)$ BRANCHING RATIOS

$\Gamma(D^0 \bar{D}^0)/\Gamma_{\text{total}}$

VALUE

DOCUMENT ID

TECN

Γ_{2/Γ}

seen

PAKHLOVA

08

BELL

 $e^+ e^- \rightarrow D^0 \bar{D}^0 \gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

not seen

AUBERT

09M

BABR

 $e^+ e^- \rightarrow D^0 \bar{D}^0 \gamma$

$\Gamma(D^+ D^-)/\Gamma_{\text{total}}$

VALUE

DOCUMENT ID

TECN

Γ_{3/Γ}

seen

PAKHLOVA

08

BELL

 $e^+ e^- \rightarrow D^+ D^- \gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

not seen

AUBERT

09M

BABR

 $e^+ e^- \rightarrow D^+ D^- \gamma$

$\Gamma(D \bar{D})/\Gamma(D^* \bar{D}^*)$

VALUE

DOCUMENT ID

TECN

Γ_{1/Γ}**0.14 \pm 0.12 \pm 0.03**

AUBERT

09M

BABR

 $e^+ e^- \rightarrow \gamma D^* \bar{D}^*$

$\Gamma(D^*(2007)^0 \bar{D}^0 + \text{c.c.})/\Gamma_{\text{total}}$

VALUE

DOCUMENT ID

TECN

Γ_{5/Γ}

seen

AUBERT

09M

BABR

 $e^+ e^- \rightarrow D^{*0} \bar{D}^0 \gamma$

$\Gamma(D^*(2010)^+ D^- + \text{c.c.})/\Gamma_{\text{total}}$

VALUE

DOCUMENT ID

TECN

Γ_{6/Γ}

seen

AUBERT

09M

BABR

 $e^+ e^- \rightarrow D^{*+} D^- \gamma$

seen

PAKHLOVA

07

BELL

 $e^+ e^- \rightarrow D^{*+} D^- \gamma$

$\Gamma(D^* \bar{D} + \text{c.c.})/\Gamma(D^* \bar{D}^*)$

VALUE

DOCUMENT ID

TECN

Γ_{4/Γ}**0.17 \pm 0.25 \pm 0.03**

AUBERT

09M

BABR

 $e^+ e^- \rightarrow \gamma D^* \bar{D}^*$

$\Gamma(D^*(2007)^0 \bar{D}^*(2007)^0 + \text{c.c.})/\Gamma_{\text{total}}$				Γ_8/Γ	NODE=M073R08 NODE=M073R08
VALUE	DOCUMENT ID	TECN	COMMENT		
seen	AUBERT	09M	BABR	$e^+ e^- \rightarrow D^0 \bar{D}^0 \gamma$	
$\Gamma(D^*(2010)^+ D^*(2010)^- + \text{c.c.})/\Gamma_{\text{total}}$				Γ_9/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
seen	AUBERT	09M	BABR	$e^+ e^- \rightarrow D^+ D^- \gamma$	NODE=M073R09 NODE=M073R09
seen	PAKHLOVA	07	BELL	$e^+ e^- \rightarrow D^+ D^- \gamma$	
$\Gamma(D \bar{D}_2^*(2460) \rightarrow D^0 D^- \pi^+ + \text{c.c.})/\Gamma_{\text{total}}$				Γ_{11}/Γ	
VALUE (units 10^{-2})	DOCUMENT ID	TECN	COMMENT		
10.5 ± 2.4 ± 3.8	15 PAKHLOVA	08A	BELL	$10.6 e^+ e^- \rightarrow D^0 D^- \pi^+ \gamma$	NODE=M073R3 NODE=M073R3
15 Using 4421 ± 4 MeV for the mass and 62 ± 20 MeV for the width of $\psi(4415)$.					
$\Gamma(D^0 D^- \pi^+ (\text{excl. } D^*(2007)^0 \bar{D}^0 + \text{c.c.}, D^*(2010)^+ D^- + \text{c.c.}))$				Γ_{10}/Γ_{11}	
$\Gamma(D \bar{D}_2^*(2460) \rightarrow D^0 D^- \pi^+ + \text{c.c.})$				Γ_{10}/Γ_{11}	
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
<0.22	90	16 PAKHLOVA	08A	BELL	$10.6 e^+ e^- \rightarrow D^0 D^- \pi^+ \gamma$
16 Using 4421 ± 4 MeV for the mass and 62 ± 20 MeV for the width of $\psi(4415)$.					
$\Gamma(D^0 D^{*-} \pi^+ + \text{c.c.})/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$				$\Gamma_{12}/\Gamma \times \Gamma_{16}/\Gamma$	
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
<0.99 × 10 ⁻⁶	90	17 PAKHLOVA	09	BELL	$e^+ e^- \rightarrow D^0 D^{*-} \pi^+$
17 Using 4421 ± 4 MeV for the mass of $\psi(4415)$.					
$\Gamma(D_s^+ D_s^-)/\Gamma_{\text{total}}$				Γ_{13}/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
not seen	PAKHLOVA	11	BELL	$e^+ e^- \rightarrow D_s^+ D_s^- \gamma$	
not seen	DEL-AMO-SA..10N	BABR	$e^+ e^- \rightarrow D_s^+ D_s^- \gamma$		
$\Gamma(D_s^{*+} D_s^{*-} + \text{c.c.})/\Gamma_{\text{total}}$				Γ_{14}/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
seen	PAKHLOVA	11	BELL	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$	
seen	DEL-AMO-SA..10N	BABR	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$		
$\Gamma(D_s^{*+} D_s^{*-})/\Gamma_{\text{total}}$				Γ_{15}/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
not seen	PAKHLOVA	11	BELL	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$	
not seen	DEL-AMO-SA..10N	BABR	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$		

$\psi(4415)$ REFERENCES

PAKHLOVA	11	PR D83 011101	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
DEL-AMO-SA..10N	PR D82 052004	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)	
MO	10	PR D82 077501	X.H. Mo, C.Z. Yuan, P. Wang	(BHEP)
AUBERT	09M	PR D79 092001	B. Aubert <i>et al.</i>	(BABAR Collab.)
PAKHLOVA	09	PR D80 091101	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
ABLIKIM	08D	PL B660 315	M. Ablikim <i>et al.</i>	(BES Collab.)
PAKHLOVA	08	PR D77 011103	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
PAKHLOVA	08A	PRL 100 062001	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
PAKHLOVA	07	PRL 98 092001	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
SETH	05A	PR D72 017501	K.K. Seth	
BAI	02C	PRL 88 101802	J.Z. Bai <i>et al.</i>	(BES Collab.)
BAI	00	PRL 84 594	J.Z. Bai <i>et al.</i>	(BES Collab.)
OSTERHELD	86	SLAC-PUB-4160	A. Osterheld <i>et al.</i>	(SLAC Crystal Ball Collab.)
BRANDELIK	78C	PL 76B 361	R. Brandelik <i>et al.</i>	(DASP Collab.)
SIEGRIST	76	PRL 36 700	J.L. Siegrist <i>et al.</i>	(LBL, SLAC)

NODE=M073

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